AC NO: 20-32B

DATE: 24 Nov 72

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: CARBON MONOXIDE (CO) CONTAMINATION IN AIRCRAFT - DETECTION AND PREVENTION

1. PURPOSE. This advisory circular provides information on the potential dangers of carbon monoxide contamination from faulty engine exhaust systems or cabin heaters of the exhaust gas heat exchanger type. It also discusses means of detection and procedures to follow when contamination is suspected.

2. CANCELLATION. Advisory Circular AC 20-32A, "Carbon Monoxide (CO) Contamination in Aircraft - Detection and Prevention," effective 9/13/68, is canceled.

3. REFERENCES.

   a. FAA Aircraft Development Service Technical Report No. ADS-80, "An Evaluation of Low Cost Carbon Monoxide Indicators."

   b. FAA Aircraft Development Service Technical Report No. ADS-29, "Analysis of Engine Exhaust System Failures in General Aviation Aircraft."

4. GENERAL. Carbon monoxide is the product of incomplete combustion of carbonaceous material. It is found in varying amounts in the smoke and fumes from burning aircraft engine fuels and lubricants. The gas itself is colorless, odorless, and tasteless but is usually mixed with other gases and fumes which can be detected by sight or smell.

   When carbon monoxide is taken into the lungs, it combines with hemoglobin, the oxygen-carrying agent in blood. The affinity of the hemoglobin for CO is so much greater than for oxygen that oxygen starvation results. Oxygen starvation of the brain reduces a person's ability to reason and make decisions. Exposure to even very small amounts of CO over a period

Initiated by: FS-140

of several hours will reduce a pilot's ability to operate an airplane safely. Long exposure to low CO concentrations is as hazardous as short exposure to relatively high concentrations.

Susceptibility to carbon monoxide poisoning increases with altitude. As altitude increases, air pressure decreases and the body has difficulty getting enough oxygen. Add carbon monoxide, which further deprives the body of oxygen, and the situation can become critical. Inhalation of tobacco smoke also introduces CO into the body in significant quantities.

Many light aircraft cabins are warmed by air that has been circulated around the engine exhaust pipes. A defect in the exhaust pipes or cabin heating system may allow carbon monoxide to enter the cockpit or cabin. The danger is greatest during the winter months and any time the temperature is such that use of the cabin heating system becomes necessary and windows and vents are closed. But there is danger at other times, too, for carbon monoxide may enter the cabin through openings in the firewall and around fairings in the area of the exhaust system.

5. SYMPTOMS. Early symptoms of CO poisoning are feelings of sluggishness, being too warm, and tightness across the forehead. The early symptoms may be followed by more intense feelings such as headache, throbbing or pressure in the temples, and ringing in the ears. These in turn may be followed by severe headache, general weakness, dizziness, and gradual dimming of vision. Large accumulations of CO in the body result in loss of muscular power, vomiting, convulsions, and coma. Finally, there is a gradual weakening of the pulse, a slowing of the respiratory rate, and ... death!

DON'T IGNORE CO SYMPTOMS !!

WHAT TO DO ABOUT EXHAUST ODORS OR SYMPTOMS. If you smell exhaust odors or begin to feel any of the symptoms previously mentioned, you should immediately assume carbon monoxide is present and should take the following precautions:

a. Immediately shut off the cabin air heater and close any other openings that might convey the engine compartment air to the cabin.

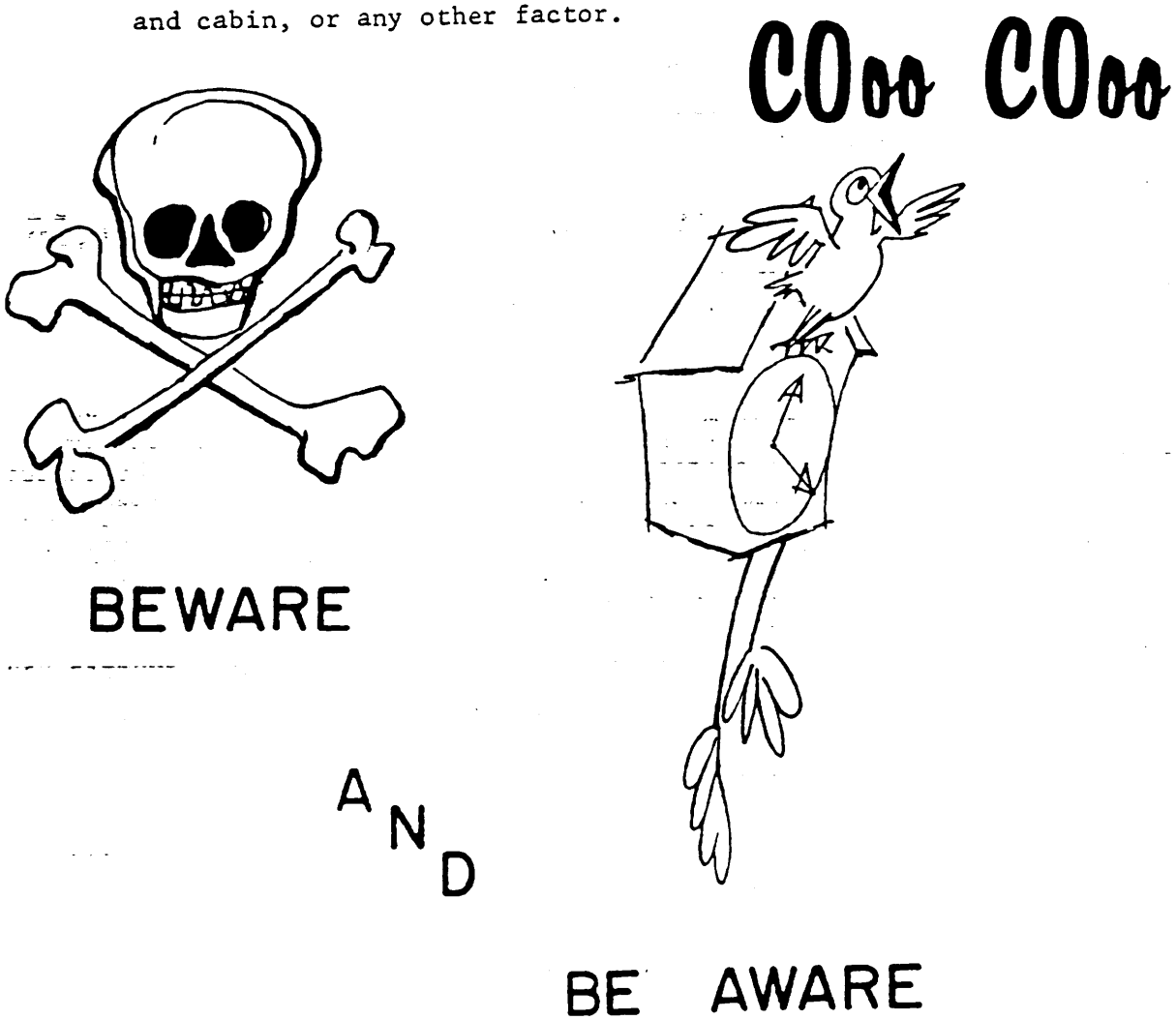
b. Open a fresh air source immediately.

c. Avoid smoking.

d. Inhale 100 percent oxygen if available.

e. If you are flying, land at the first opportunity and ensure that any effects from CO are gone before further flight.

f. Determine that CO is not being allowed to enter the cabin because of a defective exhaust, unsealed opening between engine compartment and cabin, or any other factor.



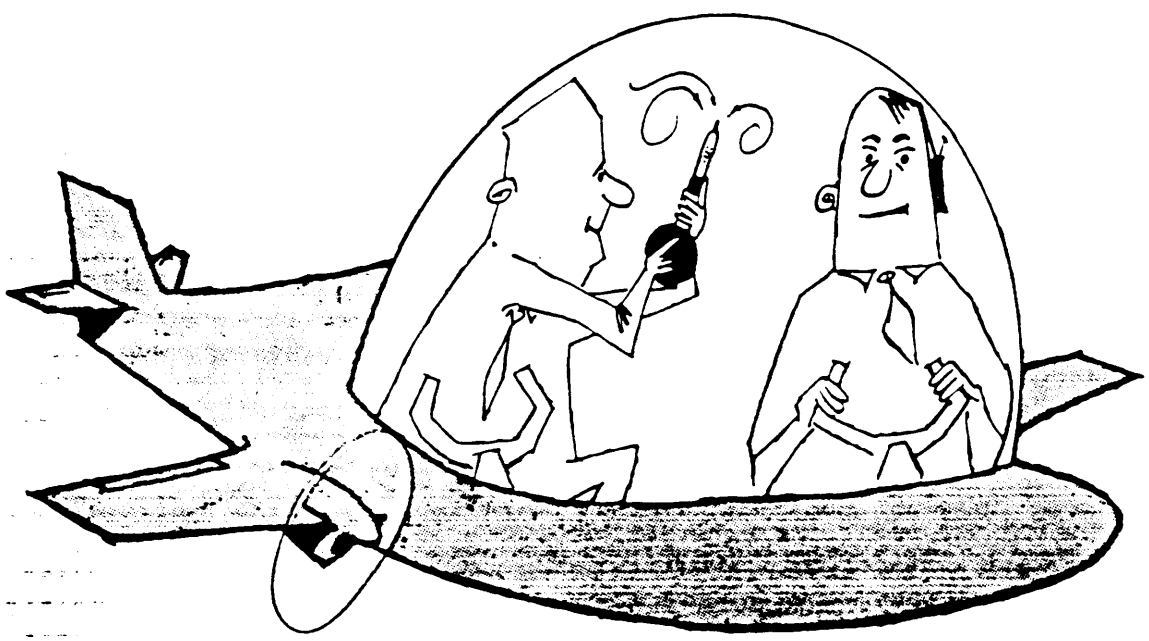
HAD YOUR EXHAUST SYSTEM INSPECTED LATELY ?

7. IS YOUR AIRCRAFT A DEATHTRAP? Concentrations of CO exceeding one part in 20,000 parts of air (0.005 percent) are hazardous. To prevent an airplane from becoming a deathtrap, a thorough examination of the exhaust manifold and heater assembly should be conducted at regular intervals and whenever CO contamination of the cockpit or cabin is suspected because cracks and holes may occur in a relatively short time. Some aircraft manufacturers recommend that exhaust and heater systems be inspected as often as every 25 hours of flight time. Carbon monoxide in the cabin or cockpit has been traced to worn or defective exhaust stack slip joints, exhaust system cracks or holes, openings in the engine firewall, "blowby" at the engine breather, defective gaskets in the exhaust manifold, defective mufflers, and inadequate sealing or fairing around strut fittings on the fuselage.

Other ways to experience CO contamination are to follow jet aircraft on takeoff, or to take a position downwind of a jet airplane that is "ground holding" prior to takeoff. If possible, aircraft should be positioned out of the exhaust area of preceding aircraft.

8. OPERATIONAL CHECKS. It is a good practice to supplement inspections of cabin heating and engine exhaust systems with operational CO detection tests. Carbon monoxide tests are reliable and may be accomplished without any disassembly operations. Tests should be conducted on the ground and in flight to determine the extent of CO contamination. These tests should be conducted with the cabin heat both "on" and "off."

9. CARBON MONOXIDE DETECTION EQUIPMENT. There are two types of indicators currently available that are practical for determining the concentration of CO in the air at any given time. One type is operated by drawing a sample of air into a transparent tube containing material which changes color according to the amount of CO present. An accurate measurement of the CO in the sample may be made by comparing the color in the tube to a color standard provided with the instrument.



PUT YOUR MIND AT REST WITH A CO TEST.

Another type of CO indicator consists of a porous plastic disc about the size of a dime mounted in a solid plastic plate about two inches square and one tenth of an inch thick. The porous plastic contains a chemical that changes color upon contact with carbon monoxide. Measurement of the CO present is made by exposing the porous plastic disc to the atmosphere to be tested for a specific period of time, then comparing the disc color to a color standard on the "instruction card." A reading of "safe," "marginal," or "dangerous" is determined. Although not as accurate as the first type, its accuracy is adequate, and it has the advantage of being light in weight and low in cost. Only one model of plate type indicator has been tested by FAA. This is the model described in Paragraph 10d below. *

USE OF CO DETECTION EQUIPMENT

a. Instructions for operating the sampling type indicator are furnished with each instrument. The actions listed in paragraph 6 of this advisory circular should be taken immediately if a CO concentration of more than 0.005 percent is indicated.

b. The plate type indicator should first of all be verified by the user as a type that functions properly. With a properly functioning detector and an appropriate color chart, the following technique has been found to be effective: Remove the transparent plastic cover from the plate thus exposing the disc to the atmosphere. After three minutes of timed exposure, compare the color of the disc with the color chart. If the exposure indicates a "dangerous" condition, the actions listed in paragraph 6 of this advisory circular should be taken immediately. If there is any question about the degree of hazard present, the exposure may be continued for a timed total of 15 minutes as a verification of the 3-minute reading. * *

c. A plate, once exposed and found to have no appreciable disc discoloration may be left exposed in the cabin for up to 30 days. If, within that period, a distinct discoloration of the disc is noted, repeat the above procedure using a new unused plate. The sensitized spot will darken in the presence of humidity, CO, and other gases, but exposing the spot to direct sunlight and fresh air may restore it to its original color, indicating a serviceable condition. After 30 days' exposure, the plate is no longer serviceable.

d. The plate type indicator which the FAA tested and found satisfactory was a two-inch by two-inch square buff-colored plastic plate with a dime-size buff-colored sensitized spot (not an off-white plate with a brown-colored spot). It may or may not be labeled: DETECTOR CARBON MONOXIDE INDICATOR. The instruction card developed by FAA and labeled, INSTRUCTIONS FOR USE OF "DETECTOR" CARBON MONOXIDE INDICATOR, will be helpful to use with the indicator. This card has a color index with six gradations of color (not three) on the front *

* side and TEST INSTRUCTIONS plus GENERAL REMARKS on the back. It is punched with five holes (not two).

11. REPORT AVAILABILITY. FAA Aircraft Development Service Technical Report No. ADS-80 titled "An Evaluation of Low Cost Carbon Monoxide Indicators" describes the tests conducted by FAA on the CO indicator. It also contains a reproduction of the color index. The report, which received wide distribution initially, is no longer available from FAA. It may be purchased for $6.00 per copy from:

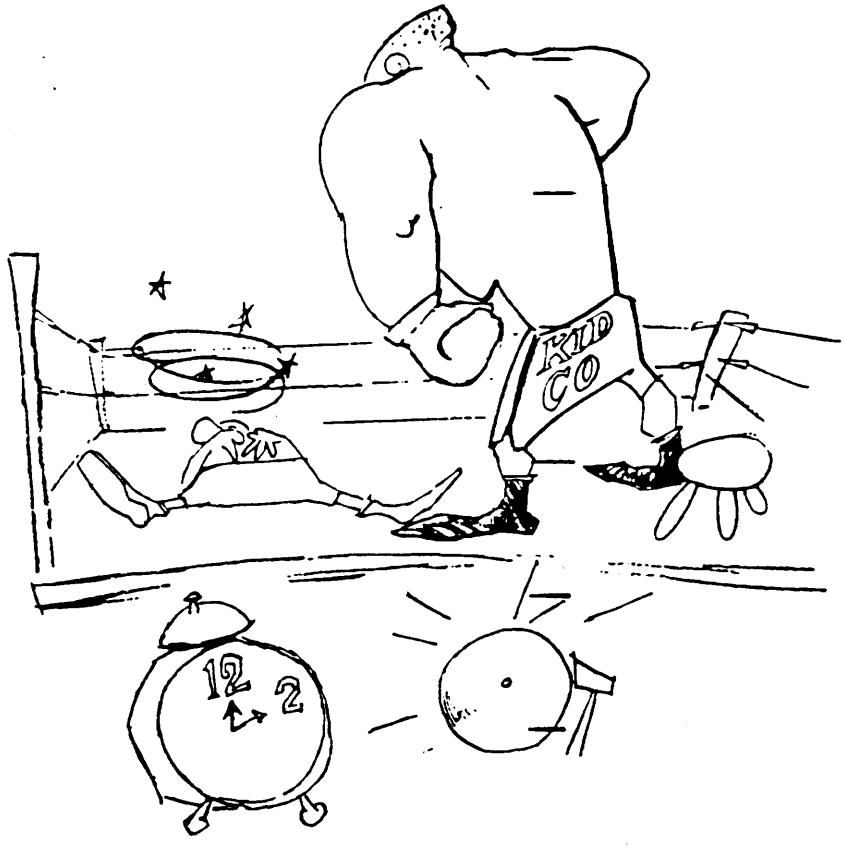
National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22151

Orders should include NTIF Accession No. AD 461670 together with the ADS report number and title. *

James F. Rudolph

JAMES F. RUDOLPH
Director, Flight Standards Service

DON'T BE—



KO'd by CO!

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